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Review of Documents for Operable Unit 2, Site ST012, at the Former Williams Air Force Base, Mesa, AZ

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CSS-Dynamac Technical Points of Contact (POCs):

Daniel F. Pope, Biologist
Anne Busher, DATS Program Manager

CSS-Dynamac
CSS-Dynamac
4900 Olympic Boulevard
Erlanger, KY 41018

[SEQ CHAPTER \h \r 1][SEQ CHAPTER \h \r 1]**INTRODUCTION**

CSS-Dynamac was tasked by the U.S. Environmental Protection Agency (USEPA) with providing comments related to a proposed enhanced bioremediation (EBR) effort for Operable Unit (OU) 2 Site ST012 (Site), at the Former Williams Air Force Base, Mesa, AZ (EPA Region 9).

The site-related documents used for site information are:

> Addendum #2 Remedial Design and Remedial Action Work Plan – Site ST012. Amec Foster Wheeler Environment & Infrastructure, Inc. November 30, 2015. (Work Plan) *Draft_ST012_RD-RAWP_Addendum2_Section1.pdf*
>
> Site ST012 Update. BRAC Cleanup Team Call. 17 December 2015. (17 December 2015 Update). *December 2015 BCT Slides_ST012_.pdf.*
>
> Appendix E Enhanced Bioremediation and SEE Containment Modeling Report. (EBR Modeling Report). *Final_ST012_RD-RAWP_052014 Appendix E.pdf.* May 2014.

The Site is at the former Liquid Fuels Storage Area, where fuel storage and distribution facilities were located until decommissioning in 1991. Contamination of soil and groundwater occurred when jet petroleum grade 4 (JP-4) and aviation gasoline (AVGAS) was released. Benzene, toluene, ethylbenzene, total xylenes, and naphthalene (BTEX+N), are indicated in the Site Work Plan to be the contaminants of primary concern (COPC; COC) that require treatment to achieve remediation goals.

As part of remedial activities, steam enhanced extraction (SEE) is being used for the removal of light non-aqueous phase liquid (LNAPL) at specified thermal treatment zones (TTZs). EBR is planned to address BTEX+N in groundwater and LNAPL remaining in the TTZs after SEE, and also outside of the TTZs. The EBR effort involves the injection of sulfate as a terminal electron acceptor (TEA) to enhance the anaerobic biodegradation of the COCs.

Once EBR reduces benzene concentrations, monitored natural attenuation (MNA) will be used to achieve the final cleanup goals. The 17 December 2015 Update indicates that:

> "100 to 500 µg/L [benzene concentration, in micrograms per liter] was set as the goal for SEE in the interior as the concentration range where natural attenuation can complete degradation within the remedy timeframe…" (17 December 2015 Update, Slide 30)

The Work Plan indicates that:

> "EBR will be implemented to achieve conditions (residual COC/COPC groundwater concentrations) at ST012 such that contaminants will degrade by natural attenuation to achieve the cleanup levels within the projected remedial timeframe (i.e., about 20 years) after completion of EBR." (Lines 1104-1107, Work Plan)

COMMENTS AND RECOMMENDATIONS

Conceptually, sulfate reduction (i.e., enhanced sulfate reduction/EBR using injected sulfate as an electron acceptor, and afterwards MNA relying on natural sulfate reduction) seems likely to be useful for degradation of the COCs dissolved in groundwater. However, given the considerable mass of source material (i.e., mobile/residual LNAPL) remaining, the practical efficacy of EBR/MNA towards achieving Site remedial goals in the desired timeframe is highly uncertain.

MNA is not ordinarily expected by USEPA (USEPA 2009 pp 2-3) to be used where uncontrolled source material remains, but the Site documentation is clear that significant source material (residual LNAPL, and quite likely mobile LNAPL) is expected to remain after cessation of SEE and EBR.

Contaminant concentrations, geochemistry, etc., in the injection and extraction wells can be significantly affected by injection and extraction activity, and data obtained from these wells should be analyzed/interpreted separately from data taken from monitoring wells not used for injection and extraction. Monitoring wells not used for injection and extraction should be used as the primary source of data for determining contaminant degradation, geochemical conditions representative of the aquifer volumes, EBR endpoints, etc.

Given that there are relatively few wells set aside for monitoring only, and those wells appear to be concentrated in the interior of the Site, it would be useful to consider installation of monitoring wells that sample the Site in a more representative manner (i.e., laterally and vertically).

It appears that the endpoints for EBR ("100 to 500 μg/L", "EBR will be implemented to achieve conditions…", as quoted above in the Introduction section of this review) are vague and somewhat arbitrary, in that:

> 1) the endpoint contaminant concentrations indicated for EBR ("100 to 500 μg/L") encompass a wide range,
>
> 2) no particular sampling locations are specified (e.g., sampling locations providing data representative, in a statistically valid and defensible way, of the various subsurface zones throughout the Site) for providing the concentration data to be used for determining the endpoint,

3) no approach is specified for determining that the endpoint concentration has been met (e.g., a statistically valid, non-arbitrary procedure for analyzing the data), and

4) part of the EBR endpoint determination appears to involve use of mathematical models of Site processes (e.g., groundwater flow, biodegradation/reactive transport) to estimate when EBR has achieved "conditions (residual COC/COPC groundwater concentrations) at ST012 such that contaminants will degrade by natural attenuation to achieve the cleanup levels within the projected remedial timeframe (i.e., about 20 years) after completion of EBR." (Lines 1104-1107, Work Plan). Given the high uncertainty connected with input data and parameters used in such models, it is to be expected that estimates of contaminant attenuation rates in different volumes of the Site subsurface over long periods of time under varying groundwater flow, geochemistry, and microbiological conditions, are subject to high uncertainty.

Note that all modeling and statistical approaches should be clearly shown to meet USEPA data quality objectives, and should incorporate uncertainty analyses (USEPA 2009), including sensitivity analyses, confidence limits on predicted values, etc. The uncertainty analyses should clearly indicate the variability of Site data, and how that variability influences assessment (i.e., understanding of current Site conditions, including hydrogeology, contamination, geochemistry, and microbiology) and predictions of contamination nature, contaminant extent (3D location) and contaminant degree (concentration/mass, including attenuation rates), and of future changes in Site conditions (hydrology, geochemistry, microbiology, etc.).

Data analyses, and predictions of contaminant and geochemistry values, extent, and changes, should be presented in narrative, tabular, and graphical form to enhance communication of the current and expected conditions, and the associated uncertainty of measurements and predictions. Generally the data analyses and predictions should be updated at least annually for the life of the remedy, to generate updated attenuation rate constants, time-frame predictions, etc., using the latest data.

Milestones (e.g., contaminant concentrations achieved at specified locations on specified dates) should be determined, for both EBR and MNA, so that it can be determined in a reasonably substantive way (i.e., not arbitrary, but in a determinate fashion) whether the Site remedial approaches are continuing to progress in such a way as to meet remedial goals in the specified timeframe. USEPA 1999 indicates that "the progress of MNA toward a site's remediation objectives should be carefully monitored and compared with expectations." (USEPA 1999, p2)

Procedures should be provided so that if it is determined that milestones are not being met, either:

1) specific plans can be implemented to enhance the existing remedial approach (e.g., for EBR, more reagent injections, more injection points, better injection/extraction approaches to distribute reagents, change in reagents, etc.), or

2) pre-planned contingency remedy(ies) can be implemented. Note that USEPA policy guidance for MNA (USEPA 1999, p24) indicates that contingency remedies should be prepared for implementation in case MNA is not meeting Site remedial goals. Also, USEPA expects that MNA remedies based on predictive analyses (i.e., modeling) should have contingency remedies prepared for implementation.

For contingency remedies, USEPA 1999 indicates that:

> "Where MNA's ability to meet these [remedial] expectations is uncertain and based predominantly on predictive analyses, decision makers should incorporate contingency measures into the remedy." (USEPA 1999, p2)

Also, USEPA 1999 indicates that:

> "EPA believes that contingency remedies should generally be included as part of a MNA remedy which has been selected based primarily on predictive analyses rather than documented trends of decreasing contaminant concentrations." (USEPA 1999, p25)

The presumed future efficacy of MNA at the Site must be regarded as based on predictive analyses.

Therefore contingency measures should be included in remedial plans so as to be ready for implementation if performance monitoring of MNA indicates that MNA is not achieving Site remedial objectives in a timely fashion, as indicated in the discussion above.

REFERENCES

USEPA. 1999. Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites. OSWER Directive 9200.4-17P. April 21, 1999. Office of Solid Waste and Emergency Response.

USEPA. 2009. EPA Quality System.
http://www.epa.gov/quality/qa_docs.html